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(54) **METHOD FOR HANDLING AND TRANSFERRING LASTS FOR ASSEMBLYING SHOES**

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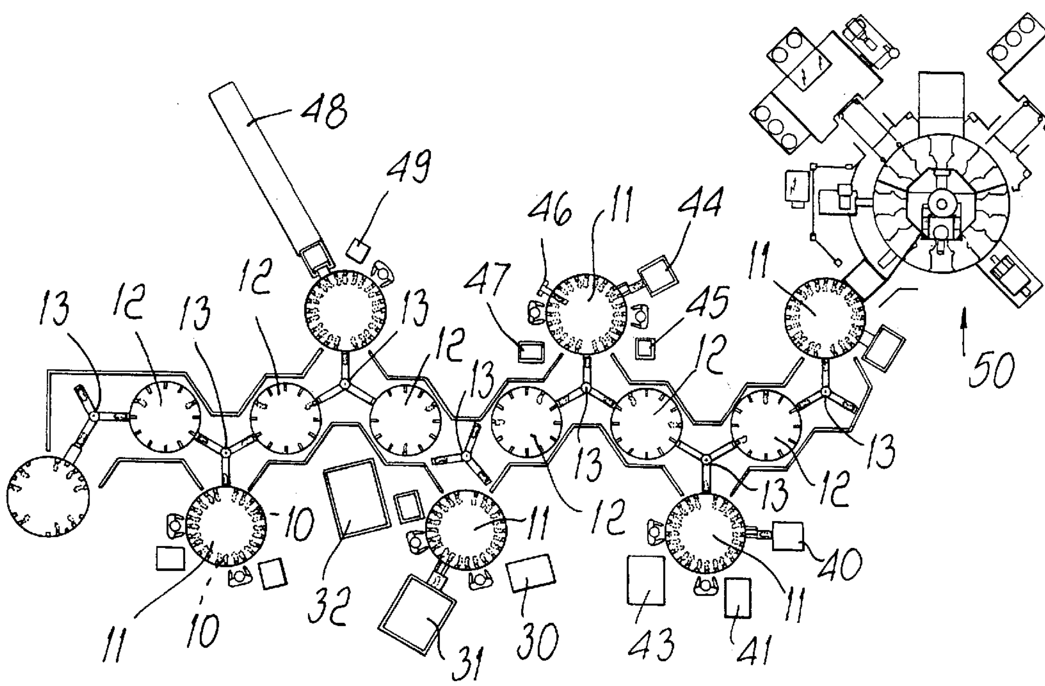
(57) **ABSTRACT**

A method for handling and transferring lasts for assemblying shoes, wherein a last is moved so as to trace: a first circular arc, a straight segment which is perpendicular to the first circular arc, and a second circular arc which is perpendicular to the straight segment. The first and second circular arcs belong to two distinct and spatially separate circles. The method uses a plurality of rotating units and is designed so that it can be used both with human operators and with automatic and/or semiautomatic machines. The invention provides total integration of a transfer system with a handling device in. order to achieve production flexibility.



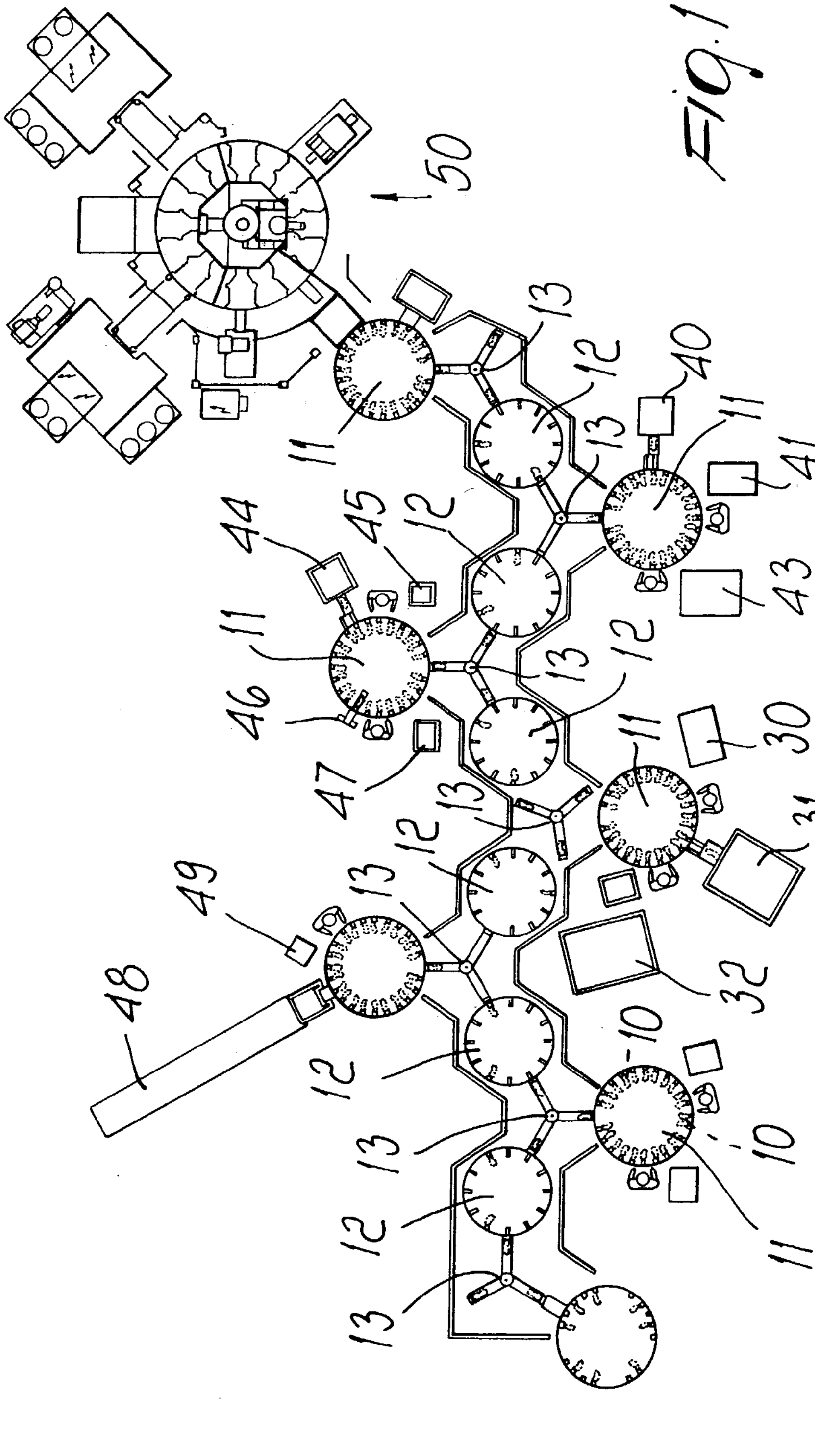


Fig. 1

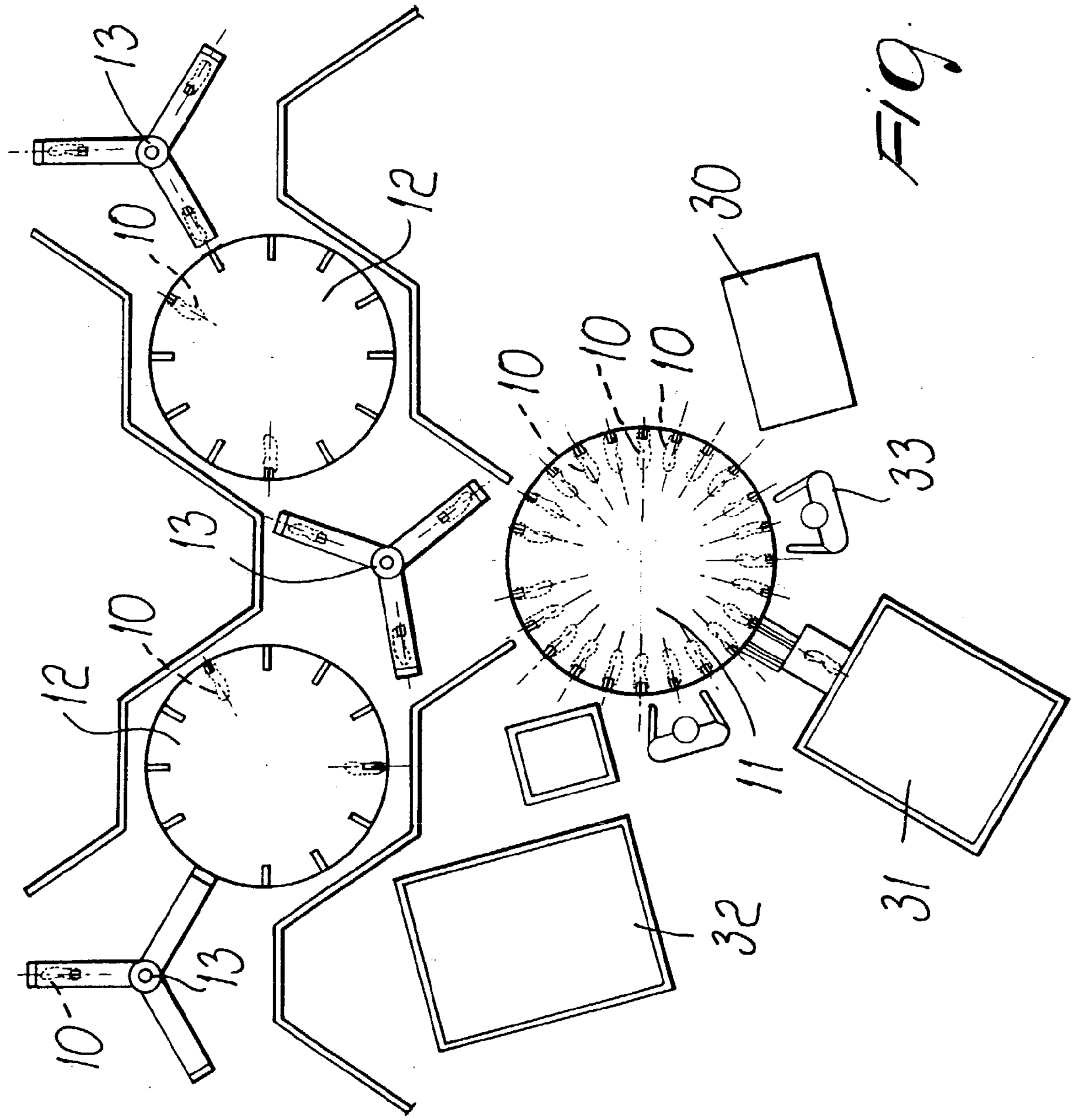


Fig. 2

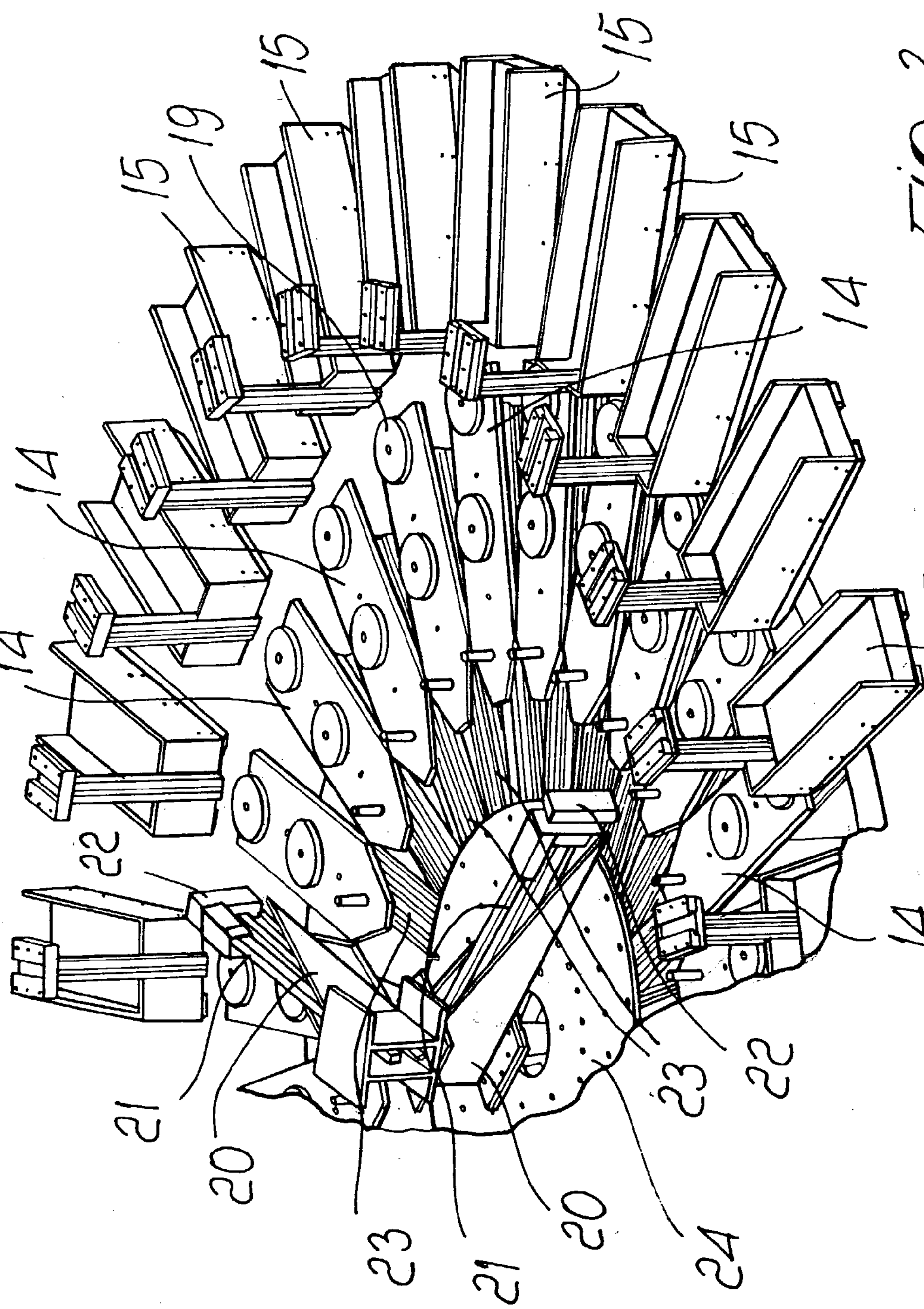


FIG. 3

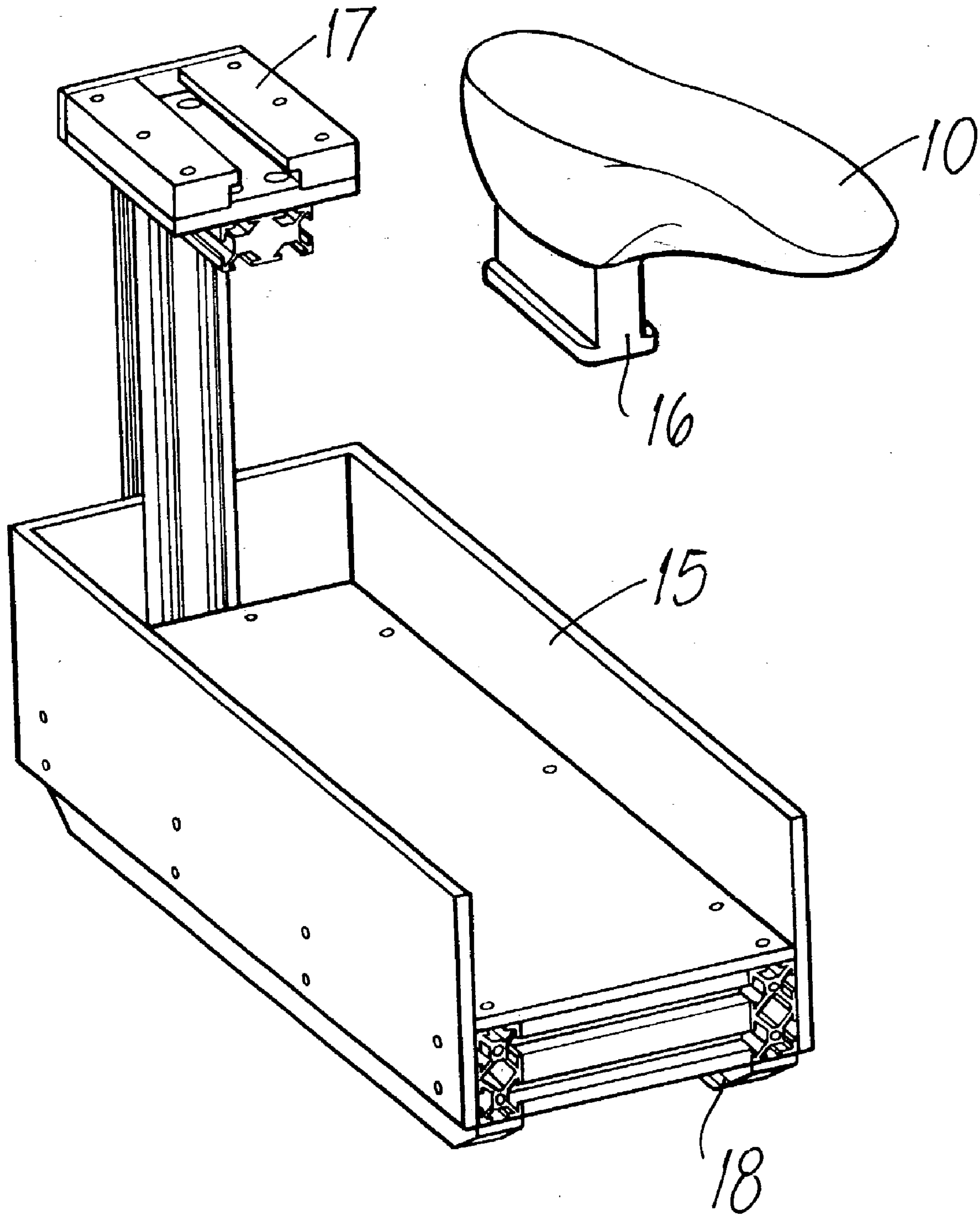


Fig. 4

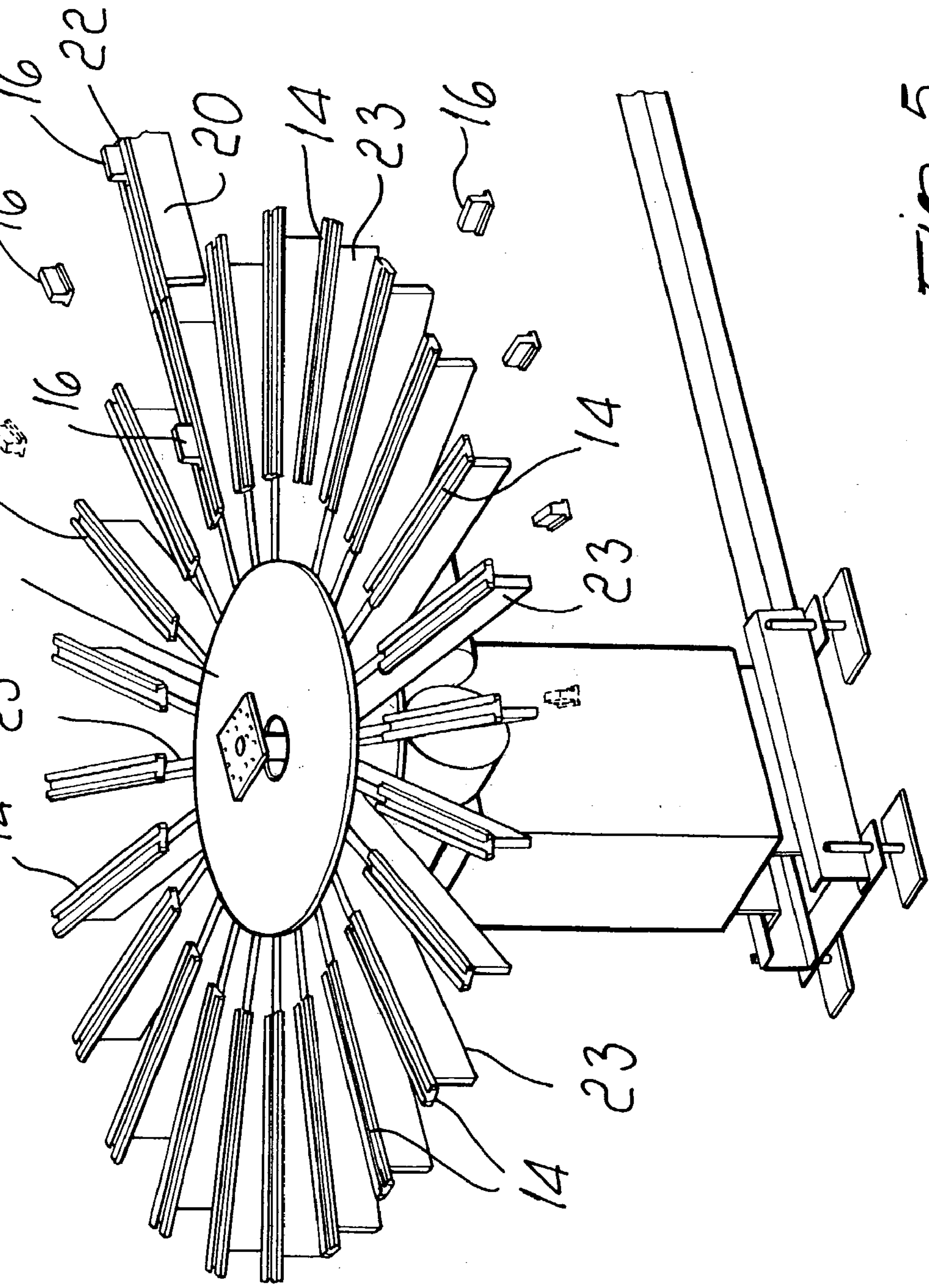


Fig. 5

METHOD FOR HANDLING AND TRANSFERRING LASTS FOR ASSEMBLYING SHOES

TECHNICAL FIELD

[0001] The invention relates to a method for handling and transferring lasts for assemblying shoes. In general, the shoes are assembled on a last which supports the shoe during all assembly operations.

BACKGROUND ART

[0002] In the shoemaking sector, the handling and transfer of lasts, semifinished parts and components is currently performed mainly by using a system comprising a swing-tray conveyor. The conveyor consists of a track supported by a metallic structure which accommodates a certain number of multiple-platform carriages or swing-trays. The swing-trays are moved by a chain which is actuated by a gearmotor producing a slow advancement motion. The term "last" designates the support on which the shoe is assembled.

[0003] Systems of this type are known from IT-1,233,886, EP-0236655, U.S. Pat. No. 4,304,020, and FR-257452. Those systems generally have several drawbacks and it is generally impossible, or very difficult, to perform production work directly on the conveyor. The last is in fact not provided with systems for centering on the conveyor, and the same is true for the semifinished parts. Attempts have been made in the past to provide the swing-tray with adapted bracket systems in order to provide a spatial reference for the lasts, but a problem would arise: either the handling unit that should pick the last and place it on the treatment machine is sufficiently sophisticated and expensive to be able to synchronize with the speed of the conveyor, or it is necessary to stop the motion of the swing-trays in order to allow loading/unloading operations. Further, it is impossible to make fast items overtake other slow ones. The swing-trays are in fact suspended one behind the other from a common advancement system; overtaking is therefore impossible. Fast items, i.e., items which do not require all the operations, are forced to move at the same speed of the slow ones. It is also impossible to ensure flexible management of urgent jobs and of individual batches or limited quantities. The need to reconcile buffer storage requirements on the conveyor with the need to process different items forces one to give the conveyor a slower speed and optimize work so as to comply with this limitation. This forces operators to anticipate or chase the conveyor, moving by a few meters to reach the swing-tray that has advanced or to go and get the material that perhaps has not yet arrived. Moreover, the conveyor is very long and therefore very bulky, because S-shaped paths are inherently not advisable; at most, L-shaped or U-shaped configurations are acceptable. Finally, handling of the lasts from and to the conveyor is exclusively manual. Accordingly, approximately 30% of the time that elapses, for each last, from loading onto the conveyor to its removal, is due to operations for handling the lasts on the part of the operators without adding value to the finished product. The result is an intense movement of hands to and from the conveyor in order to handle the materials and feed the machines. Therefore, although new technologies have led to a highly advanced development of the treatment machines, using electronic and computer technology for gluing machines, roughing machines, tacking machines, pulling and lasting machines, heel seat lasting machines et cetera, all these efforts risk being thwarted because the operator remains an indispensable factor in the handling of the lasts and semifinished parts.

[0004] More recently, in order to overcome the above drawbacks, a technology has been developed which is known as palletized transfer with soft accumulation. In these systems, the conveyor is replaced by a transfer system with a ribbed belt and the semifinished items are accommodated on pallets. Examples of embodiment of this type are disclosed in IT-1,234,088, FR-2,705,872, FR-2,742,426, EP-0691089, EP-0689778, EP-0691089, EP-0329007, and U.S. Pat. No. 4,639,963. Those technologies have allowed the automatic execution of some treatments on shoes by using, in most cases, anthropomorphic robots of the type disclosed in FR-2,586,908. However, this system has several drawbacks. First of all, the spatial arrangement of each pallet is not determined beforehand and therefore each pallet must be provided with identification markings, such as labels, colored signals, bar codes or microchip transponders, so as to transmit a signal which is capable of identifying the content of the pallet along its entire path. This entails not only a financial cost but also problems in terms of the reliability of the reading of these signals on moving parts.

[0005] Moreover, the dimensions of the pallet are not flexible, so that it is possible to set up either a pallet capable of transferring only the last or a pallet capable of transferring the sole and the components as well. However, it is very difficult to provide the two options in a same system. Further, these systems have a considerable linear extension, even more than the conveyor, because the pallet system tends to extend horizontally while the conventional conveyor extends vertically. Moreover, in order to allow singling out, centering and other operations on the pallets, technical spaces become necessary. Finally, the storage facilities that can be provided with this system require a very large ratio of volume to number of lasts, because also the pallets are stored. Accordingly, this worsens the space occupation problems. Finally, anthropomorphic robots, usable for work on these systems, have very high costs for this sector and this aspect alone can compromise the application of this system.

DISCLOSURE OF THE INVENTION

[0006] The aim of the present invention is to overcome the above-noted drawbacks with a method for handling and transferring lasts for assemblying shoes, each shoe being assembled on one of the lasts, wherein at least one of the lasts is moved so as to trace a first circular arc, a straight segment which is substantially perpendicular to said first circular arc, and a second circular arc which is substantially perpendicular to said straight segment; said first and second circular arcs belonging to two distinct and spatially separated circles.

[0007] For the purposes of the present invention, the term "perpendicular" with reference to the relationship between a straight segment and a circular arc must of course be understood in the sense of a right-angled arrangement between the straight segment and the tangent to the circular arc in the point where the straight segment encounters the circular arc.

[0008] Preferably, after the second circular arc the last is moved so as to trace a second straight segment which is spatially distinct from the first straight portion and is substantially perpendicular to the second circular arc.

[**0009**] Preferably, after the second straight segment the last is moved so as to trace a third circular arc which is substantially perpendicular to the second straight segment; the first, second and third circular arcs belonging to three distinct and spatially separated circles.

[**0010**] Preferably, after the third circular arc the last is moved so as to trace a third straight segment which is spatially distinct from the first and second straight segments and is substantially perpendicular to the third circular arc.

[**0011**] According to another aspect, the invention relates to a method for handling and transferring lasts for the assembly of shoes, each shoe being assembled on one of the lasts, wherein at least one of the lasts is moved so as to perform a plurality of movements which are spatially mutually distinct, each movement including a circular arc and a straight segment which is substantially perpendicular to the circular arc, so that the straight segments transfer the last from one circle to another spatially distinct one, so that the last is moved along a plurality of circles which are spatially distinct from each other.

[**0012**] The invention also relates to a device for assembling shoes, each shoe being assembled on a last, comprising: a plurality of rotating units, each of which supports a plurality of supports, each meant to support one of the lasts, and a transfer unit for transferring the last from one rotating unit to the other.

BRIEF DESCRIPTION OF THE DRAWINGS

[**0013**] The present invention will become better apparent with reference to an embodiment of the invention, described with reference to the accompanying drawings, which are provided only by way of non-limitative example of the invention and wherein:

[**0014**] **FIG. 1** is a schematic plan view of the device according to the invention;

[**0015**] **FIG. 2** is a schematic plan view of a detail of the device of **FIG. 1**;

[**0016**] **FIG. 3** is an enlarged-scale perspective view of a detail of the device of **FIG. 1**;

[**0017**] **FIG. 4** is an enlarged-scale perspective view of a detail of the device of **FIG. 3**; and

[**0018**] **FIG. 5** is a perspective view of a second embodiment of the device according to the invention.

WAYS OF CARRYING OUT THE INVENTION

[**0019**] With reference to FIGS. **1** to **5**, the device is used for the assembly of shoes, each shoe being assembled on a last **10**. In particular, the last **10** supports the application of the upper and the sole, according to per se known systems. Each one of a plurality of rotating units **11**, **12** and **13** supports a plurality of supports **14**. Each support **14** supports a last **10** either directly or by means of an interposed container **15**. The container **15** is used to contain additional material which is useful for the assembly of the shoe, such as for example the sole, the upper et cetera. If the container **15** is used, the last **10** is supported by a block **16**, having a shape adapted to interlock within a corresponding block **17** provided on the container **15**. According to this embodiment, the container **15** has, in its lower part, a coupling **18** adapted to couple to a corresponding member **19** provided on the support **14**.

[**0020**] As an alternative, if the container **15** is not used, the block **17** is arranged in the place of the coupling **19**, so that the block **16** that supports the last is directly coupled on the support **14**, without interposing the container **15**.

[**0021**] The embodiment of **FIG. 3** illustrates the case in which the container **15** is used. The embodiment of **FIG. 5** illustrates the case in which the block **16** is coupled directly onto the support **14**.

[**0022**] A transfer unit is provided in order to transfer the last **10** from one rotating unit **11**, **12**, **13** to the other.

[**0023**] A transfer unit **20** is provided for each component with which the rotating unit is interfaced.

[**0024**] Production rotating units **11** are provided in order to perform the operations for the assembly of a shoe; the rotating units are accordingly adapted to be coupled to machines dedicated to specific functions, such as a heel seat pounding machine **30**, a heel seat lasting machine **31**, a pulling and lasting machine **32**, or directly to an operator **33** whose task is, for example, to remove tacks. Handling rotating units **13** are provided in order to transfer the lasts **10** from one unit to another, and storage rotating units **12** are provided in order to also provide distributed storage for the lasts **10**.

[**0025**] In the embodiment shown in the figures, a production rotating unit **11** may have a single transfer unit **20**, because it is interfaced only with a handling rotating unit **13**. A storage rotating unit **12** may have two transfer units **20**, because it is interfaced with two handling rotating units **13**, and a handling rotating unit **13** may have three transfer units **20**, because it is interfaced with two storage rotating units **12** and a production rotating unit **11**.

[**0026**] Each transfer unit **20** is arranged at the center of the rotating unit **11**, **12**, **13** and comprises a motorized arm **21** and a pusher body **22** in order to transfer the last **10** from one unit to the other. The arm **21** has a single degree of freedom in order to minimize transfer times. However, it is possible to add other degrees of freedom for additional functions.

[**0027**] Each one of the rotating units **11**, **12** and **13** comprises a plurality of arms **23**. An internal end of each arm **23** is supported by a motorized part **24** of the rotating unit, so that each arm **23** can trace a circular arc during its motion. An outer end of the arm **23** supports the support **14**, which is in turn adapted to support the last **10**.

[**0028**] According to the embodiment shown in the figures, each handling unit is interfaced with three production rotating units or storage rotating units. However, according to an alternative embodiment, it is also possible to interface each handling rotating unit with four production rotating units or storage rotating units.

[**0029**] The rotating units can move in angular steps, covering identical angles, within the same rotating unit, so that after each movement the lasts can be moved along the circle of each rotating unit **11**, **12** and **13** and occupy mutually different positions, but within spatially predefined positions around the rotating unit. In this manner, the device has a finite and known number of states.

[0030] Preferably, the number of preset positions of a production rotating unit **11** or of a storage rotating unit **12** is a multiple of the number of interfaces of the handling rotating unit **13**. In this way, if, as in the embodiment shown in the figures, the handling rotating unit **13** is interfaced with three other rotating units, the number of preset positions of the production rotating unit **11** and of the storage rotating unit **12** is a multiple of three.

[0031] The device comprises a plurality of modules, and each module comprises a handling rotating unit **13**, a production rotating unit **11** and a storage rotating unit **13**. Each module has its own autonomous operation, but the mutual coupling of the various modules provides the greatest advantages of the invention.

[0032] In the form of coupling described with reference to the accompanying figures, the device comprises a linear arrangement formed by an alternating succession of handling rotating units **13** and of storage rotating units **12** and also comprises lateral extensions formed by production rotating units **11**. The production rotating units **11** are coupled to the linear arrangement at the handling rotating units **13**. This provides a complete structure, as shown with particular reference to **FIG. 1**, in which the operations for manufacturing the shoes are all performed at the production units **11**, such as the roughing machine **40**, the coarse roughing machine **41**, the tacking machine **43**, the gluing machine **44**, the sole gluing machine **45**, the reactivator **46**, the sole mating and pressing machine **47**, the finishing line **48**, the screw-type heel coupling and lace untying machine **49**, and the injection-molding carousel **50**.

[0033] The rotation of each rotating unit, as mentioned, occurs by angular steps; if, for example, x=12 and y=24, the minimum angular step for the storage rotating unit is $S_{aT}=360°/x=360°/12=30°$ and for the production rotating unit the minimum angular step is $S_{aT}=360°/y=360°/24=15°$. If m=3, for the production rotating unit one has: $S_{aT}=360°/m=360°/3=120°$.

[0034] The choice of x=12, y=24 and m=3 is preferred because of:

[0035] general advantages, which also relate to worker ergonomics, the physical volume of the invention, the capability of the invention to accumulate and transfer parts, et cetera;

[0036] advantages linked to practical results in the dynamic behavior of the invention when subjected to various operating conditions.

[0037] The fact of having angular steps ensures that at each change of state, i.e., at each angular step, the spatial reference of each object being moved is always maintained. In other words, it is not necessary to perform part centering operations after moving it by an angle α; centering is a consequence of the availability of the angular steps. The system has a finite and known number of states, by virtue of which it is possible to determine in each instant the position of a part that has entered the system without continuously monitoring the position of each part. It is sufficient to identify each part only once, preferably only at the input of the system. Various methods, such as transponders, bar codes et cetera, can be used to identify the parts.

[0038] Each module, i.e., each set of three units, is controlled by a local intelligent electronic/computerized unit, for example a PLC, which is capable of communicating with a system at a higher level by means of field bus systems or Ethernet systems or other systems. The high-level system, which is termed herein "handling system control", is capable of routing objects along the invention, delegating to the local intelligent units the operations to be performed: part expulsion, part collection, component rotation, et cetera, and all the management of the sensors (proximity sensors, limit switches, photocells, et cetera) and the interfacing with the manufacturing machines. The choice of the rules and policy for control of the invention is therefore implemented by designing and laying multiple layers of software running on the various processing systems (PC and PLC).

[0039] In practice, therefore, after loading the parts and thus after enabling the system to know at all times the position of each part, without the need for any further sensing except for redundancy checks, the lasts **10** are moved through the structure, according to requirements, without particular constraints, since the lasts can move back and forth along the structure according to the particular manufacturing processes that are necessary.

[0040] The system is flexible both from the mechanical point of view and from the point of view of production; it in fact allows to arrange around the system the stations that deal with the manufacturing processes that affect the parts. By virtue of its shape, the manufacturing stations can be moved without compromising the execution of the operations.

[0041] It should be noted that each manufacturing unit is considered as a component capable of clustering around itself manufacturing processes for which a sequence is necessary. The system therefore allows management of overtaking and bypasses (production flexibility) according to:

[0042] the type of manufacturing process to be performed on the part;

[0043] the number of operations performed on the part;

[0044] the technology used to produce the part;

[0045] the number of parts constituting each production batch;

[0046] the priority (or preemption) of one production batch with respect to another.

[0047] The invention has solved various problems in relation to conventional systems and has introduced some advantages:

[0048] It is an integrated system. In soft-accumulation systems, in which the parts are typically transferred by means of pallets, the object to be processed has to be stopped and locked in place in order to perform the manufacturing processes. Typically, the manufacturing processes are performed on the transfer line by means of multiple-axis robots which are extremely expensive. The technology of soft accumulation is unlikely to allow integration with "conventional" automatic machines, because in such case, in addition to having to lock the part in transit, one would have to transfer the part from the line to the machine by means of a handling system. The invention is instead an integrated transfer and handling system which allows to also use conventional automatic machines, not necessarily robots, for the manufacturing processes. The invention behaves, according to the situations, as a distributed storage and transfer unit, as a handling unit, and as a worktable.

[**0049**] Teamwork is possible. The invention in fact allows a plurality of operators facing the same manufacturing unit to work in close cooperation, allowing them to work according to the general criteria of the Toyota and kanban methods. Moreover, in case of temporary absence of one operator, the others can easily move to the vacant post and perform the work of the missing operator as well.

[**0050**] Good mechanical modularity and easy configuration is provided; by choosing x=12, y=24 and m=3 (where x and y are multiples of m), the system according to the invention allows to build units having a high mechanical modularity and capable of being configured very easily.

[**0051**] It is a man-oriented and machine-oriented structure. The invention is in fact well-suited for interfacing with operators and with automatic machines, allowing proper cohabitation of these production resources.

[**0052**] Considerable accumulation (buffer storage and WIP) is allowed. Two contrasting requirements occur in the shoemaking industry: to have a reasonably small number of parts involved and at the same time to have a certain number of these parts in order to ensure free-air seasoning. The configurations that can be provided with the invention allow proper balance between these two quantities.

[**0053**] Overtaking and bypassing functions for groups of operations are allowed. The overtaking and bypassing functions are strongly felt needs in manufacturing fields which, owing to the nature of the manufactured goods, in order to schedule the production plans, et cetera, require batch overtaking according to priority, precedence and preemption. The logic structure of the invention in fact inherently comprises two movement loops: a manufacturing loop **11**, i.e., a loop capable of controlling operators and machines, and a fast transfer loop **12** and **13**, i.e., a loop capable of moving the lasts so as to minimize the transfer times and allow overtaking and bypassing.

[**0054**] Individual batch management is ensured. The production of samples or, generally, of small batches can in fact become a priority operation. In view of the above, one can say that management of the individual batch or unit batch is often likened to an urgent job and therefore fast execution is required.

[**0055**] The system has a finite number of states, i.e., it can be likened to a sort of matrix in which each cell represents the spatial arrangements of the parts being conveyed. The cells change state, depending on which part occupies which cell, in known time quanta.

[**0056**] The number of part recognition devices to be used is limited and is used only at the input of the device. The parts can in fact be marked with microchip transponders, bar codes or other systems. Once a part in transit at the inlet of the invention has been identified, by means of the finite-state structure it is in theory possible to follow its path simply by analyzing the states of the automaton, but it is still possible to use distributed recognition systems. Because of this, further recognition devices in addition to the one located at the input are not required.

[**0057**] Extensions in non-canonical directions are allowed. The choice of the tern of x, y, m with multiple values allows to provide structures which can branch in various directions, forming straight, L-shaped, C-shaped, S-shaped structures, et cetera.

[**0058**] The necessary accumulation in front of the operators is ensured. In some manufacturing fields, the operator assigned to performing a certain task may require the simultaneous presence of more than one part. With the invention, the mutually adjacent arrangement of the parts to be subjected to manufacturing processes allows the operator who is in the above conditions to access without difficulty the parts that he needs.

[**0059**] Manufacturing processes performed directly on the manufacturing units **11** are allowed. Manual assembly operations, as well as some manufacturing processes, can be performed directly on the unit, which acts as a worktable.

[**0060**] Direct manufacturing processes on the manufacturing units are allowed even with simplified robots. Since rotations through known angular steps are available, after locking in place the part to be processed it is possible to interface the invention with robots having multiple axes, including robots with parallel kinematic systems, which can work directly on the production rotating units. Each part is in fact constantly given a spatial reference and therefore indexing processes are not required, as instead occurs in soft-accumulation systems.

[**0061**] The structure allows space optimization. The choice of m=3 in fact has implications for space optimization. The manufacturing units **11** are spaced from the units that deal with the transfer **12** and **13** while ensuring the correct technical spaces for maneuvering and maximum utilization of the work area.

[**0062**] It is a flexible architecture. The expandable nature of the invention in fact includes three aspects: the mechanical one, the electronic one and the computerized one. As regards the mechanical aspect, it has already been stated that the device has good mechanical modularity, capable of ensuring easy reconfigurations. From the electronic standpoint, expanding the invention entails the connection of field connectors (bus or network) and the programming of the intelligent units. The last aspect, i.e., the computerized one, entails updating the configuration map, consequently defining the new routings of the parts being processed according to the production plan and to its scheduling.

1. A method for handling and transferring lasts for assemblying shoes, each shoe being assembled on one of said lasts, characterized in that at least one of said lasts is moved so as to trace a first circular arc, a straight segment which is substantially perpendicular to said first circular arc, and a second circular arc which is substantially perpendicular to said straight segment, said first and second circular arcs belonging to two distinct and spatially separate circles.

2. The device according to claim 1, wherein after said second circular arc said last is moved so as to travel along a second straight segment which is spatially distinct with respect to said first straight segment and is substantially perpendicular to said second circular arc.

3. The method according to at least one of the preceding claims, wherein after said second straight segment, said last is moved so as to trace a third circular arc which is substantially perpendicular to said second straight segment; said first, second and third circular arcs belonging to three distinct and spatially separate circles.

4. The method according to at least one of the preceding claims, wherein after said third circular arc said last is moved so as to trace a third straight segment which is spatially distinct from said first and second straight segments and is substantially perpendicular to said third circular arc.

5. A method for handling and transferring lasts for assembling shoes, each shoe being assembled on one of said lasts, characterized in that at least one of said lasts is moved so as to perform a plurality of movements which are mutually spatially distinct and wherein each movement comprises a circular arc and a straight segment which is substantially perpendicular to said circular arc, so that the straight segments transfer said last from one circle to another one which is different and spatially distinct, so that said last is moved along a plurality of spatially mutually distinct circles.

6. A device for handling and transferring lasts for assembling shoes, each shoe being assembled on one of said lasts, comprising: a plurality of rotating units, each of which supports a plurality of supports, each adapted to support one of said lasts, and a transfer unit for transferring said last from one rotating unit to another.

7. The device according to claim 6, wherein said rotating unit can move, on command, by preset discrete movements, so as to engage a plurality of preset stations, so that at each movement said plurality of supports can be arranged on said preset stations, changing a relative position of said lasts.

8. The device according to at least one of claims **6-7**, wherein each one of said rotating units comprises a plurality of arms, an inner end of each arm being supported by a motorized component of said rotating unit so that each arm can trace a circular arc during movement, an outer end of said arm supporting said support.

9. The device according to at least one of claims **6-8**, characterized in that each one of said rotating units comprises a transfer unit; preferably a separate transfer unit for each component with which it is interfaced; preferably, each transfer unit is arranged at the center of said rotating unit and comprises a motorized arm and a pusher body for transferring said last; preferably, said transfer unit has a single degree of freedom.

10. The device according to at least one of claims **6-9**, wherein said plurality of rotating units comprises a plurality of production rotating units for performing operations for the assembly of said shoe and a plurality of handling rotating units for the transfer of said lasts, and comprises a plurality of storage rotating units for providing distributed storage of said lasts.

11. The device according to at least one of claims **6-10**, wherein each one of said handling rotating units is interfaced with three or four production rotating units or storage rotating units, preferably with three production rotating units or storage rotating units; preferably, said storage rotating unit is provided with **12** supports and said production rotating unit is provided with 24 supports.

12. The device according to at least one of claims **6-11**, wherein a number of preset positions of said production rotating unit or of said storage rotating unit is a multiple of the number of interfaces of said handling rotating unit.

13. The device according to at least one of claims **6-12**, wherein said support supports a container for containing accessories for assembling said shoe, said container preferably having an auxiliary support for supporting said last.

14. The device according to at least one of claims **6-13**, comprising a plurality of modules, each module comprising a handling rotating unit, a production rotating unit and a storage rotating unit.

15. The device according to at least one of claims **6-14**, comprising a linear arrangement formed by an alternating succession of production rotating units and of said handling rotating units.

16. The device according to at least one of claims **6-15**, wherein said rotating units can move by angular steps.

17. The device according to at least one of claims **6-16**, wherein said device has a finite and known number of states.

* * * * *